

# Tissue composition of sponges from the Weddell Sea, Antarctica: not much meat on the bones

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**ABSTRACT:** The tissue of 31 demosponge and 7 hexactinellid species was analyzed for its composition of organic and inorganic matter. With one exception (*Haliclona* cf. *gaussiana*) inorganic matter, i.e. mostly the siliceous skeleton, accounted for most of the dry weight, varying between about 60 and 95 % dry wt. There were no general trends in the ratio of organic to inorganic matter within sponge orders or genera, and within one species, the ratio could vary between stations. For one of the hexactinellids, *Bathydorus spinosus*, several size classes were analyzed and there was no systematic change in the organic:inorganic matter ratio with specimen size. For some species the results from the Weddell Sea sponges are in good agreement with earlier data from McMurdo Sound. The low organic matter content in Weddell Sea sponges implies that sponge biomasses are much lower than hitherto assumed on the basis of their high abundances and large sizes. In consequence, Antarctic sponges, despite their ubiquitousness, may only channel a minor fraction of the general benthic-pelagic flow of matter and energy, and their main role in the ecosystem is likely structural rather than dynamic.

**KEY WORDS:** Sponges · Antarctica · Tissue composition · Demosponges · Hexactinellids · Inorganic skeleton

## INTRODUCTION

Sponges are dominant members of many Antarctic benthic communities (Beliaev & Ushakov 1957, Koltun 1969, 1970, Dayton et al. 1970, Voss 1988, Barthel et al. 1990). Most of the ca 300 different species known from the Antarctic are demosponges; only 28 species of hexactinellids are currently recognized (Barthel & Tendal 1994). Although only represented by comparatively few species, hexactinellids are important structural agents in this ecosystem. When living, they serve as a habitat for numerous other benthic organisms (Dearborn 1977, Gutt 1988, Wägele 1988, Barthel et al. 1991, Kunzmann 1992); the persistent skeletons of dead hexactinellids form the major part of the well-known Antarctic spicule mats, thereby modifying the substrate conditions for other benthic fauna (Barthel 1992a, b, Barthel & Gutt 1992). The demosponge species investigated by Kunzmann (1992) harbour a less rich fauna, and demosponge skeletons, composed of mostly small spicules, do not have the same structural properties as those of hexactinellids.

While we possess some information on the structural role of sponges in Antarctic benthic ecosystems, we have virtually no knowledge on their participation in the flow of matter and energy from the pelagic to the benthic realm. A noteworthy exception is the now classic study by Dayton et al. (1974), which gives data on tissue composition, growth rates, abundances of and predation on a number of sponges from the shallow part of McMurdo Sound.

In this contribution, data on the body composition of 37 dominant sponge species from the eastern Weddell Sea shelf are presented as a first step towards assessing their role in benthic-pelagic coupling.

## MATERIAL AND METHODS

Sponge material was collected during leg 3 of the 'European Polarstern Study' (EPOS) cruise along the eastern Weddell Sea shelf. Particulars on sites and station lists are compiled in Arntz et al. (1990). The sponges were dredged with either Agassiz or large

Table 1 Tissue composition of Antarctic demosponges (means  $\pm$  SD). Depth values are depth at beginning and end of bottom time. A: Agassiz trawl; G: large bottom trawl; B: benthopelagic trawl

| Species                                    | Stn and trawl type | Depth (m) | DW (% WW)         | AFDW (% DW)       | (% DW)            | Ash (% WW)        | n  |
|--|--------------------|-----------|-------------------|-------------------|-------------------|-------------------|----|
| <b>Choristida</b>                          |                    |           |                   |                   |                   |                   |    |
| <i>Monosyringa longispina</i>              | 284 G              | 402–412   | 22.31 $\pm$ 3.03  | 25.49 $\pm$ 3.46  | 74.52 $\pm$ 3.46  | 16.66 $\pm$ 2.64  | 6  |
| <b>Spirophorida</b>                        |                    |           |                   |                   |                   |                   |    |
| <i>Tetilla leptoderma</i>                  | 293 G              | 771–793   | 24.74 $\pm$ 5.88  | 25.34 $\pm$ 1.86  | 74.66 $\pm$ 1.86  | 18.53 $\pm$ 4.65  | 21 |
|  | 249 G              | 499–515   | 26.46             | 16.69             | 83.31             | 22.09             | 3  |
|  | 274 A              | 196–212   | 20.81 $\pm$ 4.78  | 23.95 $\pm$ 6.02  | 76.05 $\pm$ 6.02  | 16.01 $\pm$ 4.77  | 11 |
|  | 211 G              | 207–213   | 50.86 $\pm$ 18.27 | 14.89 $\pm$ 0.63  | 85.11 $\pm$ 0.63  | 43.23 $\pm$ 15.37 | 5  |
|  | 235 G              | 405–407   | 33.04 $\pm$ 2.79  | 34.16 $\pm$ 4.19  | 65.84 $\pm$ 4.19  | 21.83 $\pm$ 3.03  | 8  |
| <i>Tetillid</i> sp.                        | 241 G              | 451–453   | 17.56             | 23.21             | 76.79             | 13.50             | 3  |
| <i>Cinachyra antarctica</i>                | 274 A              | 196–212   | 29.64 $\pm$ 5.12  | 39.67 $\pm$ 2.63  | 60.33 $\pm$ 2.63  | 17.92 $\pm$ 3.41  | 13 |
| <i>Cinachyra barbata</i>                   | 274 A              | 196–212   | 30.43 $\pm$ 7.56  | 16.85 $\pm$ 4.39  | 83.15 $\pm$ 4.39  | 25.45 $\pm$ 7.19  | 12 |
|  | 224 G              | 186–187   | 35.02             | 29.87             | 70.13             | 24.31             | 2  |
| <b>Hadromerida</b>                         |                    |           |                   |                   |                   |                   |    |
| <i>Polymastia invaginata</i>               | 235 G              | 405–407   | 35.55 $\pm$ 2.41  | 16.01 $\pm$ 4.54  | 83.99 $\pm$ 4.54  | 29.91 $\pm$ 3.15  | 10 |
| <i>Polymastia isidis</i>                   | 275 A              | 301–330   | 39.37             | 10.27             | 89.73             | 35.37             | 2  |
| <i>Tentorium papillatum</i>                | 241 G              | 451–453   | 32.80 $\pm$ 4.11  | 38.14 $\pm$ 4.00  | 61.86 $\pm$ 4.00  | 20.44 $\pm$ 3.73  | 5  |
|  | 235 A              | 399–404   | 37.25             | 32.48             | 67.52             | 25.24             | 3  |
| <i>Suberites</i> sp.                       | 241 G              | 451–453   | 24.58             | 19.22             | 80.78             | 19.84             | 2  |
| <i>Pseudosuberites nudus</i>               | 248 G              | 599–602   | 52.73 $\pm$ 3.71  | 6.06 $\pm$ 2.76   | 93.94 $\pm$ 2.76  | 49.56 $\pm$ 4.17  | 5  |
| <i>Latrunculia apicalis</i> (red)          | 261 B              | 798–799   | 22.59 $\pm$ 3.82  | 27.08 $\pm$ 5.16  | 72.92 $\pm$ 5.16  | 16.62 $\pm$ 3.88  | 5  |
| <b>Poecilosclerida</b>                     |                    |           |                   |                   |                   |                   |    |
| <i>Mycale acerata</i>                      | 272 A              | 406–409   | 24.29             | 16.80             | 83.20             | 20.20             | 2  |
| <i>Isodictya erinacea</i>                  | 284 G              | 402–412   | 47.12             | 15.12             | 84.88             | 40.10             | 2  |
|  | 241 G              | 451–453   | 39.76 $\pm$ 4.49  | 18.25 $\pm$ 2.85  | 81.75 $\pm$ 2.85  | 32.58 $\pm$ 4.44  | 16 |
| <i>Isodictya cavicornuta</i>               | 258 B              | 484–509   | 17.84 $\pm$ 3.30  | 22.93 $\pm$ 4.13  | 77.07 $\pm$ 4.13  | 13.70 $\pm$ 2.32  | 18 |
| <i>Isodictya toxophila</i>                 | 284 G              | 402–412   | 41.01             | 14.30             | 85.70             | 35.23             | 2  |
|  | 235 G              | 405–407   | 45.30 $\pm$ 7.30  | 8.63 $\pm$ 3.15   | 91.37 $\pm$ 3.15  | 41.31 $\pm$ 6.28  | 9  |
|  | 245 A              | 483–484   | 39.18 $\pm$ 3.24  | 12.87 $\pm$ 1.01  | 87.13 $\pm$ 1.01  | 34.69 $\pm$ 2.96  | 11 |
|  | 291 G              | 499–515   | 41.66             | 14.04             | 85.97             | 35.81             | 2  |
|  | 248 G              | 599–602   | 29.90 $\pm$ 4.13  | 9.13 $\pm$ 0.70   | 90.87 $\pm$ 0.70  | 27.19 $\pm$ 3.92  | 5  |
|  | 249 G              | 701–702   | 33.43 $\pm$ 1.53  | 8.03 $\pm$ 0.36   | 91.97 $\pm$ 0.36  | 30.75 $\pm$ 1.50  | 4  |
| <i>Desmacidon ramosa</i>                   | 275 A              | 301–330   | 23.20             | 18.44             | 81.56             | 18.93             | 1  |
| <i>Myxodoryx hanitschi</i>                 | 272 A              | 406–409   | 24.62             | 14.78             | 85.22             | 21.06             | 3  |
| <i>Tedania tantula</i>                     | 271 A              | 352–399   | 23.96 $\pm$ 6.56  | 17.70 $\pm$ 1.94  | 82.30 $\pm$ 1.94  | 19.75 $\pm$ 5.54  | 11 |
|  | 235 G              | 405–407   | 27.02 $\pm$ 5.98  | 14.74 $\pm$ 2.52  | 85.26 $\pm$ 2.52  | 23.16 $\pm$ 5.74  | 6  |
| <i>Tedania oxeata</i>                      | 229 A              | 500–509   | 27.97 $\pm$ 5.69  | 10.54 $\pm$ 2.65  | 89.46 $\pm$ 2.65  | 25.15 $\pm$ 5.85  | 9  |
|  | 235 G              | 405–407   | 32.82 $\pm$ 8.19  | 7.36 $\pm$ 2.58   | 92.64 $\pm$ 2.58  | 30.59 $\pm$ 8.50  | 5  |
|  | 275 A              | 301–330   | 32.22             | 11.74             | 88.26             | 20.68             | 3  |
|  | 235 A              | 399–404   | 40.90 $\pm$ 4.19  | 6.25 $\pm$ 1.31   | 93.75 $\pm$ 1.31  | 38.37 $\pm$ 4.35  | 7  |
|  | 256 B              | 382–399   | 15.72             | 14.79             | 85.21             | 13.45             | 3  |
| <i>Tedania vanhoeffeni</i>                 | 256 B              | 382–399   | 10.89 $\pm$ 1.51  | 33.92 $\pm$ 3.41  | 66.08 $\pm$ 3.41  | 7.19 $\pm$ 1.06   | 6  |
| <i>Tedania triraphis</i>                   | 241 A              | 457–462   | 15.54 $\pm$ 1.10  | 28.63 $\pm$ 2.77  | 71.37 $\pm$ 2.77  | 10.70 $\pm$ 1.03  | 4  |
|  | 271 A              | 352–399   | 17.30 $\pm$ 7.51  | 32.34 $\pm$ 14.34 | 67.66 $\pm$ 14.34 | 9.46 $\pm$ 2.23   | 5  |
| <i>Artemisina plumosa</i>                  | 248 G              | 599–602   | 44.22 $\pm$ 6.04  | 13.81 $\pm$ 2.68  | 86.19 $\pm$ 2.68  | 38.17 $\pm$ 5.68  | 13 |
|  | 241 G              | 451–453   | 24.39 $\pm$ 2.11  | 23.79 $\pm$ 0.94  | 76.21 $\pm$ 0.94  | 18.58 $\pm$ 1.58  | 4  |
| <i>Artemisina apolloni</i>                 | 235 A              | 399–404   | 35.74             | 7.14              | 92.86             | 33.19             | 1  |
| <i>Ectyodoryx ramilobosa</i>               | 249 G              | 701–702   | 22.57 $\pm$ 5.56  | 15.24 $\pm$ 2.83  | 84.76 $\pm$ 2.83  | 19.03 $\pm$ 4.17  | 5  |
|  | 235 G              | 405–407   | 44.52 $\pm$ 2.32  | 14.55 $\pm$ 1.91  | 85.45 $\pm$ 1.91  | 37.87 $\pm$ 1.15  | 3  |
| <i>Iophon spatulatus</i>                   | 241 G              | 451–453   | 24.58             | 19.22             | 80.78             | 19.84             | 1  |
|  | 271 A              | 352–399   | 11.63             | 18.61             | 81.39             | 9.46              | 1  |
| <i>Phorbas glaberrima</i>                  | 261 B              | 798–799   | 30.35 $\pm$ 10.26 | 16.59 $\pm$ 5.32  | 83.41 $\pm$ 5.32  | 25.81 $\pm$ 9.52  | 6  |
| <b>Haplosclerida</b>                       |                    |           |                   |                   |                   |                   |    |
| <i>Haliclona</i> cf. <i>gaussiana</i>      | 235 A              | 399–404   | 22.02             | 52.24             | 47.76             | 10.52             | 1  |
| (Hem) <i>Gellius rudis</i>                 | 235 G              | 405–407   | 29.27 $\pm$ 6.07  | 14.00 $\pm$ 1.76  | 86.00 $\pm$ 1.76  | 25.19 $\pm$ 5.31  | 9  |
|  | 241 A              | 457–462   | 19.05 $\pm$ 5.72  | 10.17 $\pm$ 1.84  | 89.83 $\pm$ 1.84  | 17.09 $\pm$ 5.15  | 11 |
| <i>Hemigellius flagellifer</i>             | 229 A              | 500–509   | 45.26 $\pm$ 10.04 | 9.99 $\pm$ 0.83   | 91.01 $\pm$ 0.83  | 41.24 $\pm$ 9.48  | 4  |
| <i>Xestospongia</i> cf. <i>coralloides</i> | 249 G              | 701–702   | 19.21             | 14.48             | 85.52             | 16.43             | 1  |

Table 2. Tissue composition of Antarctic hexactinellids (means  $\pm$  SD). Depth values are depth at beginning and end of bottom time. A: Agassiz trawl; G: large bottom trawl; B: benthopelagic trawl

| Species                     | Stn and trawl type | Depth (m) | DW (% WW)         | AFDW (% DW)       | Ash (% DW)        | Ash (% WW)        | n  |
|-----------------------------|--------------------|-----------|-------------------|-------------------|-------------------|-------------------|----|
| <i>Rossella racovitzae</i>  | 248 G              | 599–602   | 41.24             | 4.84              | 95.16             | 38.35             | 1  |
|                             | 253 A              | 1996–2012 | 36.74             | 19.32             | 80.68             | 29.64             | 1  |
|                             | 256 B              | 382–399   | 31.69 $\pm$ 2.44  | 23.06 $\pm$ 7.14  | 76.94 $\pm$ 7.14  | 24.53 $\pm$ 4.17  | 5  |
| <i>Rossella villosa</i>     | 230 A              | 270–280   | 30.63 $\pm$ 6.03  | 14.64 $\pm$ 1.80  | 85.36 $\pm$ 1.80  | 26.20 $\pm$ 5.46  | 5  |
| <i>Rossella fibulata</i>    | 230 A              | 270–280   | 34.81 $\pm$ 5.39  | 19.04 $\pm$ 4.86  | 80.96 $\pm$ 4.86  | 28.43 $\pm$ 6.15  | 4  |
|                             | 281 A              | 389–450   | 22.98 $\pm$ 1.83  | 26.71 $\pm$ 1.47  | 73.29 $\pm$ 1.47  | 16.87 $\pm$ 1.63  | 6  |
| <i>Rossella nuda</i>        | 226 G              | 569–574   | 40.03 $\pm$ 15.75 | 8.41 $\pm$ 1.44   | 91.59 $\pm$ 1.44  | 36.83 $\pm$ 14.99 | 4  |
|                             | 230 A              | 270–280   | 30.54 $\pm$ 6.46  | 18.65 $\pm$ 4.00  | 81.35 $\pm$ 4.00  | 24.96 $\pm$ 6.16  | 16 |
|                             | 281 A              | 389–450   | 25.54             | 25.94             | 74.06             | 18.92             | 1  |
| <i>Rossella vanhoeffeni</i> | 274 A              | 196–212   | 24.26             | 30.38             | 69.62             | 16.88             | 2  |
| <i>Bathydorus spinosus</i>  | 258 B              | 484–509   |                   |                   |                   |                   |    |
|                             |                    | 0–2 cm    | 25.62 $\pm$ 4.21  | 19.39 $\pm$ 2.19  | 80.61 $\pm$ 2.19  | 20.65 $\pm$ 3.44  | 11 |
|                             |                    | 2–4 cm    | 23.67 $\pm$ 4.14  | 23.05 $\pm$ 15.40 | 76.95 $\pm$ 15.40 | 18.33 $\pm$ 4.93  | 17 |
|                             |                    | 4–6 cm    | 25.49 $\pm$ 7.47  | 21.68 $\pm$ 3.15  | 78.32 $\pm$ 3.15  | 19.94 $\pm$ 5.91  | 14 |
|                             |                    | 8–10 cm   | 32.72             | 31.52             | 68.48             | 22.40             | 1  |
|                             |                    | 10–12 cm  | 25.72             | 24.46             | 75.54             | 19.43             | 1  |
| <i>Scolymastra joubini</i>  | 281 A              | 389–423   | 20.04 $\pm$ 0.53  | 27.68 $\pm$ 1.39  | 72.32 $\pm$ 1.39  | 14.50 $\pm$ 0.51  | 4  |

bottom trawls, cleaned and frozen either whole or in part, depending on size. In species possessing long anchoring spicule tufts, care was taken to include these tufts. However, the specimens were torn from the bottom by the trawl and thus the whole spicule tuft may not always have been included. Visibly incomplete specimens were not included in the analysis. In the laboratory, wet weight (WW) was determined. Then, the sponges were freeze-dried and thereafter completely dried in a drying oven for 24 h at 100°C and the dry weight (DW) was measured. Ash-free dry weight (AFDW) and ash content were determined after burning the material in a muffle furnace (500°C, 24 h).

## RESULTS

Tables 1 & 2 give the tissue composition of demosponges and hexactinellids respectively. The organic matter content, i.e. cellular material and organic skeleton, was low, ranging from 4.84% in the hexactinellid *Rossella racovitzae* to 52.24% in the demosponge *Haliclona* cf. *gaussiana*. There was no homogeneity of tissue composition within orders or even genera. A good example is the genus *Tedania*, represented by 4 species. *T. tantula* and *T. oxeata* have a hard, almost brittle consistency. Between 82.30 and 93.75% of their dry weight consisted of inorganic skeletal material. The 2 other congeners, *T. vanhoeffeni* and *T. triraphis*, are large, soft-bodied species which exude copious quantities of slime when disturbed (Barthel & Gutt 1992). In these species the content of inorganic material varied between 66.08 and 71.37% DW, i.e. was considerably

lower. Within any one species, tissue composition could vary between stations. Usually the variation was small and could not be related to the only known factor, depth, as can be seen from the data on the poecilosclerid *Isodictya toxophila* and the spirophorid *Tetilla leptoderma*, sampled from 6 and 5 different depths, respectively.

In most cases there was not enough material to investigate the influence of specimen size on tissue composition. This was only possible in the case of the hexactinellid *Bathydorus spinosus*, which occurred in large quantities at Stn. 258, and for this species, no systematic change of body composition with size could be found (Table 1).

The hexactinellids included in this study all had a low organic matter content, between 4.84 and 31.52% DW. It is noteworthy that one of the highest values, 30.38% DW, occurred in the softest of the hexactinellids, *Rossella vanhoeffeni*, a species we hardly ever found as complete specimens — only fragments — and which possesses only a negligible anchoring spicule tuft.

## DISCUSSION

The data on the body composition of Antarctic sponges show that the organic matter content is, on average, rather low (below 40%), compared with the few available data on sponges from temperate and tropical waters. The only exception is *Haliclona* cf. *gaussiana*, where the organic matter constitutes 52.24% DW. Arndt (1930), who compiled data on 6 demosponge species from shallow temperate waters,

Table 3. Ash content of Antarctic demosponges and hexactinellids. Comparison of data from shallow water in McMurdo Sound (Dayton et al. 1974, McClintock 1987) and deeper water in the Weddell Sea. Given are means (or ranges in cases where specimens from more than 1 station were analyzed). Numbers in parentheses are number of specimens investigated

| Species                      | Ash (% DW)                            |                                    |                             |
|------------------------------|---------------------------------------|------------------------------------|-----------------------------|
|                              | McMurdo Sound<br>(Dayton et al. 1974) | McMurdo Sound<br>(McClintock 1987) | Weddell Sea<br>(this study) |
| <i>Tetilla leptoderma</i>    | 76.72 (5)                             | 52.2 (3)                           | 65.84 – 85.11 (48)          |
| <i>Cinachyra antarctica</i>  | 70.26 (3)                             | 73.0 (3)                           | 60.33 (13)                  |
| <i>Mycale acerata</i>        | 82.88 (4)                             | 68.2 (3)                           | 83.20 (2)                   |
| <i>Polymastia invaginata</i> | 85.21 (3)                             | –                                  | 83.99 (10)                  |
| <i>Latrunculia apicalis</i>  | –                                     | 49.8 (3)                           | 72.92 (5)                   |
| <i>Isodictya erinacea</i>    | 79.86 (2)                             | 68.4 (3)                           | 81.75 – 84.88 (18)          |
| <i>Rossella racovitzae</i>   | 86.25 (9)                             | 77.1 (3)                           | 76.94 – 95.16 (7)           |
| <i>Rossella nuda</i>         | –                                     | 74.6 (3)                           | 81.35 (16)                  |

gives the following ranges for various tissue composition parameters: DW (% WW) 14.5 to 25.4; AFDW (% DW), 33.8 to 70.2; ash (% DW), 29.2 to 66.2; ash (% WW), 4.4 to 14.5. In other words, the water content is comparatively high in these species, because the content of mineral skeleton is much lower than in the Antarctic sponges investigated in the present study. It seems as if most Antarctic species are characterized by an extremely well-developed mineral skeleton and only a little living tissue. Comparison with data gathered by Dayton et al. (1974) and McClintock (1987) from McMurdo Sound, on the other side of the continent, indicates that this also holds true for other areas of the Antarctic (Table 3). While the data of the present study and those of Dayton et al. are in very good agreement, the values reported by McClintock for spicule (i.e. inorganic) content in the dry matter of sponges from virtually the same site as Dayton's are on average considerably lower. This discrepancy has not as yet been explained. In temperate areas, the tissue composition of sponges varies considerably with season and reproductive cycle (e.g. Barthel 1988), but within the slow-growing Antarctic sponges (Dayton 1979), which probably do not reproduce in a yearly rhythm, we may assume that there is no pronounced seasonal cycle such as that observable in temperate species; organic matter content in Antarctic sponges may be constantly low. Another factor to consider is the proportion of organic skeletal material (spongin, collagen) in the tissue of different sponge species. Hexactinellids contain hardly any skeletal protein (Mackie & Singla 1983). In contrast, organic skeleton can account for a large portion of the total organic sub-

stance in demosponges (for a discussion see Barthel 1993). This further reduces the amount of metabolically active tissue in the demosponge species.

The low content of metabolically active tissue in Antarctic sponges results in a low real biomass, even in habitats dominated by sponges. This implies that despite their ubiquitousness, high abundance and large volume, they may channel only a very minor fraction of the flow of matter from the pelagic to the benthic ecosystem. Recent calculations (A. Jarre-Teichmann pers. comm.) support this assumption, but we still lack biomass determinations and metabolic activity measurements to prove it.

Dayton et al. (1974) showed for the shallow water of McMurdo Sound that sponges were an important food source for a number of asteroid species and for the nudibranch *Austrodoris mcmurdensis*, which occurs in high abundances in the habitat. In the Weddell Sea the situation seems to be different in that large potential sponge predators are rare (Table 4). Two of the 5 asteroid species found to feed on sponges in McMurdo Sound do not occur in the eastern Weddell Sea shelf; the other 3 species are much less abundant. Equally rare are browsing and feeding marks on sponges (own obs.). The only sponge predators encountered more regularly are micropredators such as small gastropods and amphipods (Kunzmann 1992). The likely consequence is that most of the energy stored in the form of sponge tissue will ultimately enter the detrital food chain. Thus, the major influence Antarctic sponges have on their habitat is not as mediators of matter or energy flow, but as structuring agents. They add a 3-dimensional structure to an essentially flat environment, serve as habitat for a multitude of small organisms and change substratum conditions by creating a secondary hard substratum with their deposited skeletons (Barthel 1992b).

Table 4. Comparison of densities of known asteroid sponge predators in McMurdo Sound (Dayton et al. 1974) and the eastern Weddell Sea shelf (Voss 1988, own obs.)

| Species   | Abundance (no. per 1000 m <sup>2</sup> ) |                   |
|---|--|-------------------|
|   | McMurdo Sound                            | Weddell Sea shelf |
| <i>Odontaster meridionalis</i>                  | 128 ± 19                                 | 0 – 5             |
| <i>Acodontaster conspicuus</i>                  | 56 ± 17                                  | 0 – 5             |
| <i>A. hodgsoni</i>                              | 3 ± 5                                    | 0 – 5             |
| <i>Perknaster fuscus antarcticus</i><br>(adult) | 10                                       | Not found in area |
| <i>P. fuscus antarcticus</i><br>(juvenile)      | ~10                                      | Not found in area |

Evolutionarily, the high content of mineral skeleton and low amount of living tissue in Antarctic sponges may be a special adaptation to living in cold environments. If this is so, we have to expect similar proportionalities in sponges of Arctic waters and the deep sea.

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